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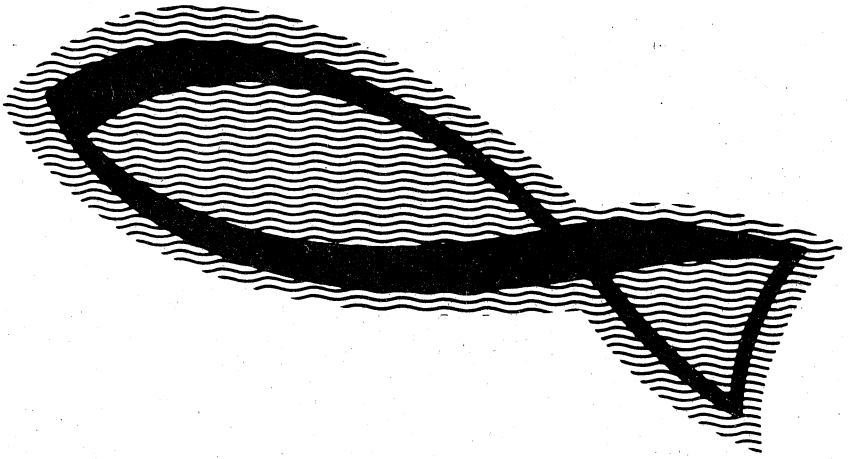

by

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DUBLIN.1.

The Effects of Drainage on the Flora and Fauna of a tributary of the River Boyne

by

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INTRODUCTION

Arterial drainage helps in the process of land reclamation by lowering the level of the existing river bed and allowing the ground water to run off more quickly. In recent years the Rivers Corrib, Dee-Glyde, and Moy have been drained. The effects of drainage on the fish stocks and the invertebrate fauna of the River Moy have been described by Toner, O'Riordan and Twomey (1965). In 1968 investigations commenced into the effects of drainage on the invertebrate fauna and flora as well as fish stocks in the Trimblestown, or Athboy, River, a tributary of the River Boyne. The Boyne rises 6.4 km from Edenderry and flows north-east for 112 km to the sea at Drogheda. It has fifteen tributary streams and two lakes in its catchment area of 2,693 square km. A section of the Trimblestown River which rises at the foot of Slieve na Calligh, Co Westmeath and flows south-east for 35 km to meet the Boyne at the town of Trim was selected (Fig. 1). Its shallowness and accessibility made it particularly suitable for the study. The study area, 4.8 km north of Athboy town, was 146 metres long and averaged 6.1 metres wide. The river flows for its entire length over Carboniferous limestone and the bed of the river consists of gravel and sandy silt, with scattered boulders and some mud in the quieter areas. There are a few pools in this section, the river being composed of riffle areas alternating with flats. The normal flow at this point was 0.77 cubic metres per second, the pH was 7.6 and the alkalinity as $CaCo_3$ was 310 p.p.m.

From 1968 and 1970 57 invertebrate fauna samples from standard areas (0.093 M^3) were taken with a suber stream bottom sampler. The plant life was mapped and an assessment of the fish population was made, by the depletion method. Cross (1972).

Pre Drainage

Fish:- The fish population in the study area was assessed by electro fishing in September 1968, by the depletion method, Cross (1972). A total of 638 fish was captured as follows:- 432 brown trout, 163 juvenile salmon, 20 eels, 14 sticklebacks and 9 stone-loach. The fish density in the area was 0.73/per M^2. The ratio of salmonids (brown trout and salmon included) to the other fish species was approximately 14:1. The brown trout population was composed of 232, 0 Group and 200 of one to four years of age. The mean length and weight of the 0 Group were 6.5 cm. and 4.2 g. Trout of age one to four years had a mean length of 15.7 cm. and a mean weight of 58.0 g. There were 4 four-year-olds in the population and these varied from 184 to 248 g. (6.5 to 8.8 ozs). Of the 163 juvenile salmon collected, 20 were 0-group salmon, with a mean length 6.1 cm and weight of 3.0 g. The remainder of the salmon were one-year-olds with a mean length of 11.4 cm and a mean weight of 20.2 g. Of the one-year-olds 55% were maturing males, no two-year-old being present in the population. The Boyne system has a predominantly one-year-old smolt class with the remainder migrating as two-year-olds (Browne unpublished 1969). Table 1 gives the density and standing crop in g/m^2 of the various fish groups in the population.

Invertebrate Fauna In August-September 1968 29 invertebrate fauna samples were taken in the study area. The dominant organism in all samples was the crustacean Gammarus duebeni, which made up 96 per cent of the total wet weight of organisms collected. The young of the freshwater crayfish Austropotamobius pallipes represented 3%, and the remaining 1% of the biomass as wet weight of living organisms was composed of mayfly nymphs, caddis larvae, dipteran larvae, beetle larvae and molluscs. The biomass of invertebrate organisms present varied with the type of stream bottom and the amount of cover available. On the water cress Rorippa nasturtium aquatica in silt and gravel with a current speed averaging 0.15 metres per second the biomass was 95.8 g/m^2. At the lower end of the scale, samples taken on stony ground with no vegetation and an average current speed of 0.34 metres per second showed a biomass of 5.4 g/m^2. The average wet weight of organisms in the twenty nine samples was 36.65 g/m^2.

Collections made in 1969 and 1970 were spread throughout the year. Four samples were taken in March 1969, six in April, seven in May, six in November, two in May and two in June 1970. The crustacean Gammarus duebeni was the dominant organism as in 1968, followed by the caddis larvae Hydropsyche sp. the mayflies Baetis rhodani and pumilus and dipteran larvae. Stonefly nymphs, beetle larvae and other insect forms made up the remaining invertebrates in the samples. There was a decline in the number of Gammarus sp. present from 72.5 per cent in 1968 to 33.7 per cent in 1969-1970. The mean biomass of the samples also fell in this period from 36.5 5g/m^2 to 22.4 8g/m^2. The average number of species present in the samples in 1969-1970 was 9.2.

Flora: A survey of the autumn flora was made in the sample area in 1968. Common among the emerged plants was the reed grass Phalaris arundinacea and the white burr reed Sparganium erectum which dominated the edges close to the banks in shallow water, also Myosotis sp. and the water mint Mentha aquatica. In deeper water the bullrush Scirpus lacustris and the mares tail Hippuris sp. were found. Along the edges in shallow water and along the banks Veronica catenate and Epilobium hirsutum were also recorded. Common among the submerged plants was the water crowfoot Ranunculus fluitans, the water-dropwort Oenanthe fluviatilis and the water cress Rorippa nasturtium. Less common were Potomageton natans and P. crispus with the star-wort Callitriche stagnalis. Mosses of the genus Fontinalis were common throughout the area.

Drainage:- The action of the dredgers is to dig out the rocks, soil and gravel of the river bed to a pre-determined depth by means of a drag-line and bucket, the spoil is then deposited on the banks. The bed of the river or the substratum is the layer where insect life predominates and in the process of drainage this layer is taken away and with it the majority of the stream invertebrates. However a number of invertebrates escape the dredger and drift downstream but the actual number is difficult to determine in silt-laden water. Drainage was completed on the stream section under review in March 1972 and on the whole river the following June. The bed level was lowered 1.5 metres in the study area and the mean width of the stream was increased from 6.1 to 6.8 m. Bank height increased from 1.0 to 2.9 m., and the banks were quite steep unlike the rounded gently sloping banks prior to drainage. Fig 2 shows a cross section of the study area before and after drainage. A longitudinal section of the area with old and new bed levels together with bank height is shown in Fig. 3. River flow which was calculated at 0.77 cubic metres per second in September 1968 prior to drainage had increased to 0.83 cubic metres per second under normal flow conditions. Suspended silt levels were very high during and after drainage. These ranged from 945 to 1889 ppm.

This resulted in the deposition of silt in the sample area which ranged in depth from 10 to 40 cm. immediately after drainage. No vegetation remained except small clumps of burr reed which had floated down from upstream and lodged along the sides and in the main bed of the river.

POST DRAINAGE

Fish:- In May 1974, two years after drainage, the area was electro-fished. Two fishings were completed before heavy rains raised the level of the stream. No other fishing was done and although the total population was not removed the two fishings gave a good indication of the various groups of fish in the study area. A total of 316 fish were removed; of these 156 were stone loach, 135 minnows, 15 brown trout, 6 gudgeon and 4 sticklebacks. The ratio of coarse fish to brown trout was 33.1, no juvenile salmon being caught. The density of fish in the study area was $0.32/m^2$ a drop of $0.38/m^2$ on pre-drainage stocks, the biomass was also low, $3.27\ g/m^2$ against $18.2\ g/m^2$ prior to drainage. Table 2 shows the density and biomass of fish in the study area. Six of the brown trout were one—year-olds, five were two-year-olds and four were three years of age. No fry of the year were captured. The average length and weight were 20.0 cm and 133 g.

However a return of salmonids was recorded in fishings carried out in November 1974. A total of 415 fish were removed from the area, 51 juvenile salmon, 15 brown trout and 345 stoneloach, minnows and stickle-backs, all the salmon were 0+ years of age and were the progeny of salmon which spawned in the area in the 1973-74 spawing season. The ratio of coarse fish to salmonids was 5:1, which was an improvement over the May census. The brown trout were composed of nine 0+ fish, two 1+ and four spent males, two were 2+ and remaining two were 3+ years of age.

The mean length and weight of the spent fish were 29.5 cm. and 339 g. These fish had either spawned in the study area or had entered it after spawning.

Invertebrate Fauna:- Bottom fauna samples were taken in March 1972 immediately after drainage was completed, and also in June of the same year. These showed the invertebrate fauna to be sparse and to be present only in clumps of vegetation that drifted down from upstream and lodged along the banks and in the river itself. In March six samples were taken on rooted vegetation and three in the main bed of the river on stones and argilacious silt. Samples taken on rooted vegetation showed that not more than six organisms were present in any one sample. The dominant species were the larvae of the caddis Hydropsyche sp. and nymphs of the mayflies Baetis rhodani and B. pumilus. Other species included the crustacean Gammarus duebeni and chironomid larva. No macro-invertebrates were found in the three samples taken on stones and silt except the remains of one small crayfish Austropotamobius pallipes.

In June eight samples were taken, five on rooted vegetation and three on stones and silt in the main bed of the river. Invertebrate fauna was still sparse but there was an improvement on the March samples. Twenty organisms were collected in one sample on rooted vegetation. The dominant organisms were the caddis larva Hydropsyche sp. (6), mayfly Baetis sp. (4); other organisms included dipteran and beetle larvae and the crustacean Grammarus duebeni. The remaining four samples taken on stones and silt contained no macro-invertebrates. The depth of silt in this area was 16 to 40 cm.

It would appear from these initial samples taken after drainage was completed that the invertebrate fauna in the area under review was seriously depleted and entirely

absent in the main bed of the river except in clumps of rooted vegetation, mostly Sparganium erectum, at the sides and in the bed of the river itself. These clumps affording cover for organisms drifting down from upstream would be a major factor in the recolonisation of the stream. The sample area was allowed to settle for a year and invertebrate fauna sampling resumed in March 1973. By this time the silt had been washed downstream and to the sides of the stream where it formed secondary banks. The bed of the river was composed of a mixture of gravel and silt except in the slow flowing areas where silt deposits were still 10-30 cm in depth. The gravel ranged in diameter from 2.0 to 10 cm with a mean 3.5 cm. Large stones which were frequent in the old stream section were, except in a few places, absent.

Twenty-five bottom fauna samples were taken between March and November 1973. These showed a good recovery of the invertebrate fauna throughout the whole area, both in the riffle and flat zones. Species numbers varied from sample to sample from six in barren stony ground and up to twenty in detritus and moss. The organisms occurring in most samples were the crustaceans Gammarus duebeni and Asellus aquaticus, nymphs of the mayflies Baetis rhodani, B. pumulis and Ephemerella ignita, the caddis larvae Hydropsyche sp. and Rhyacophila dorsalis also chironomid, simulid and tipulid larvae as well as the larvae and adults of the coleopteran Helmis maugei. Molluscs were present especially Lymnaea peregra and Potamopyrgus jenkinsi and aquatic oligochaets and mites had reappeared. In barren stony ground one sample contained as few as ten organisms whilst in detritus and moss up to one thousand organisms were counted, mostly dipteran larvae. There was a complete absence of the freshwater crayfish Austropotamobius pallipes which was plentiful prior to drainage. It was usually associated with the moss Fontinalis sp. attached to large stones. This habitat is absent from the drained section. This could well be a factor for its disappearance as well as the concentration of silt which was prevalent during drainage. Nymphs of the stoneflies have been absent except in one November sample when one nymph was present.

The biomass in grams per m^2, wet weight showed a drop of 45% on pre-drainage samples taken in 1969-1970 and a 55% drop on the September 1968 samples. The 1973 biomass ranged from 1.08 g/m^2 in stony ground with little vegetation to 36.68 g/m^2 in water cress and moss. The mean of fifteen samples taken between March and October 1973 was 12.98 g/m^2, this compares with a mean of 22.48 g/m^2 in 1969-1970 and 36.65 g/m^2 in September 1968.

Flora:- Vegetation was taking root in the stream bed and on secondary banks by the summer and in early autumn the secondary banks were fully colonised with aquatic and semi-aquatic plants, together with terrestrial grasses and buttercup. In the river itself alternating bedsof Phalaris arundinacea, the reed grass and Sparganium erectum the white burr reed, were plentiful with the water cress Rorippa nasturtium aquatica., and close to the side Callitriche sp. and Mentha aquatica. Chara sp. and fillamentous algae, which was scarce prior to drainage, were abundant in the study section.

Conclusions

The decline in the brown trout and juvenile salmon population from 595 to 15 or $0.66/m^2$ to $0.01/m^2$ two years after drainage show the effect the disturbance of drainage has had on this particular area of stream. However salmonid numbers

increased and in the November census two and a half years after drainage the ratio of coarse fish to brown trout and salmon was 5:1.

Maitland (1965) who studied the feeding relationships of salmon, trout minnows, stoneloach and sticklebacks in the River Endrick in Scotland found that there is a close similarity in that they all feed on the common aquatic invertebrates present, in the case of the River Endrick, Baetis sp. Gammarus sp and chironomid larvae. If this is to be the case in the Athboy River there will be direct competition for food between the salmonids and the coarse fish species. The rehabilitation of the stream with brown trout and salmon by natural propagation or by artificial stocking would appear to be made more difficult by the presence of these other fish species.

The invertebrate fauna, although seriously depleted in the lowering and widening of the stream bed, improved a year after drainage. The biomass was approximately 50% below pre-drainage sample weights, stoneflies and the freshwater crayfish being absent from the fauna in post drainage collections. The crustacean Gammarus duebeni decreased in numbers whilst the caddis larva Hydropsyche sp. became more plentiful in the drained section.

There was no fundamental changes in the flora which recovered well after drainage, although fillamentous algae and Chara sp. became common throughout the area, these species were not common prior to drainage.

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Table 1 The density and biomass of the fish population in the study area pre-drainage.

Species	Number of fish	Density n/m^2	Standing Crop g/m^2
Brown Trout			
0 Group	232	0.26	0.94
Group I - IV	200	0.22	12.95
Salmon			
0 - 1 Group	163	0.18	2.64
Eels	20	0.02	1.7
Stickler backs	14	0.016	+
Stoneloach	9	0.01	+
Total	638	0.70	18.2

Table 2. The density and biomass of the fish population in the study area post-drainage.

Species	Number of fish	Density n/m^2	Standing Crop g/m^2
Stone-Loach	156	0.16	0.5
Minnow	135	0.14	0.67
Brown Trout	15	0.015	2.0
Gudgeon	6	0.006	0.1
Sticklebacks	4	0.004	+
Total	316	0.32	3.27

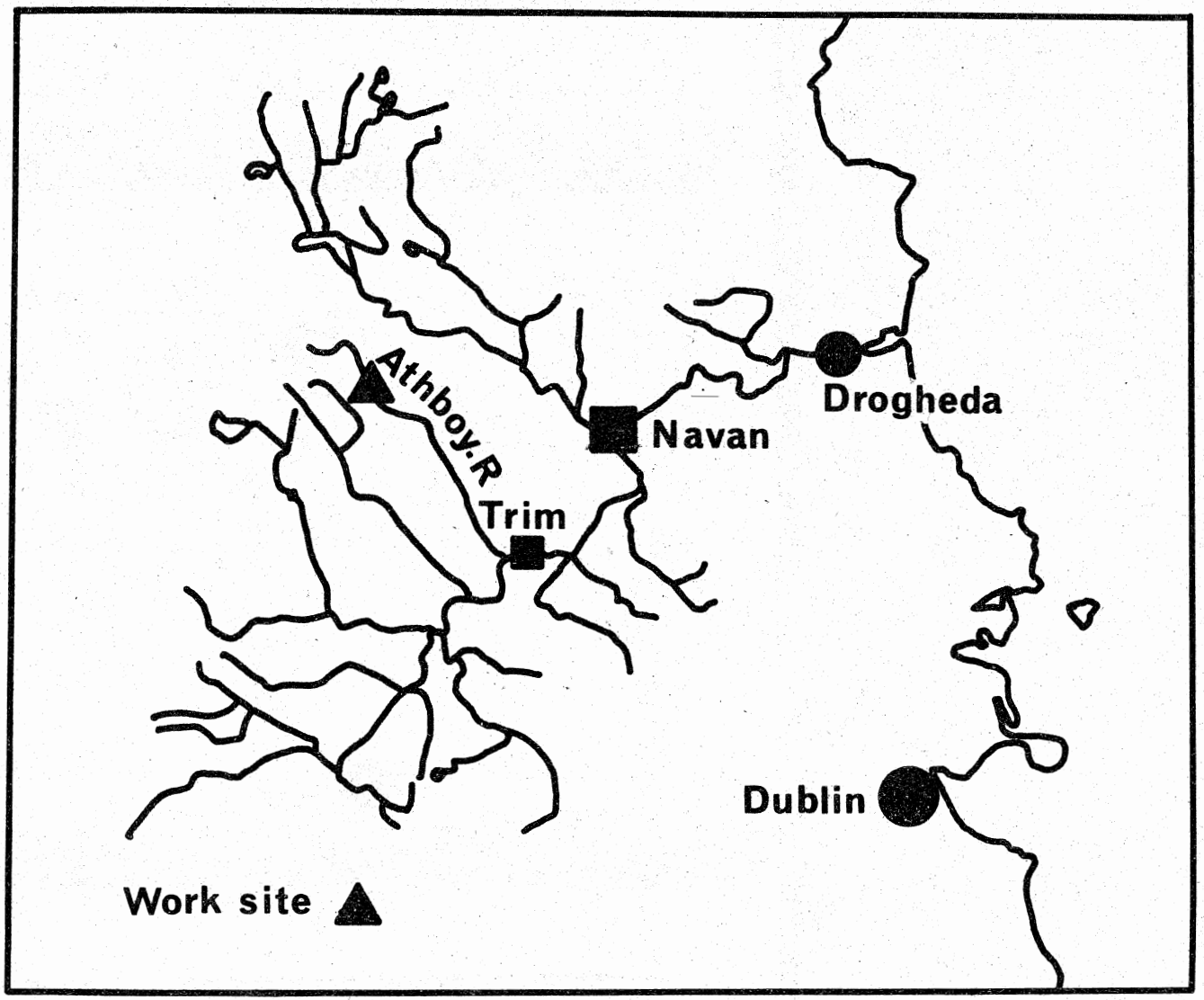

Fig. 1 Catchment area of River Boyne Ststem, showing the work site on the Athboy or Trimblestown River. (Permit No. 1933).

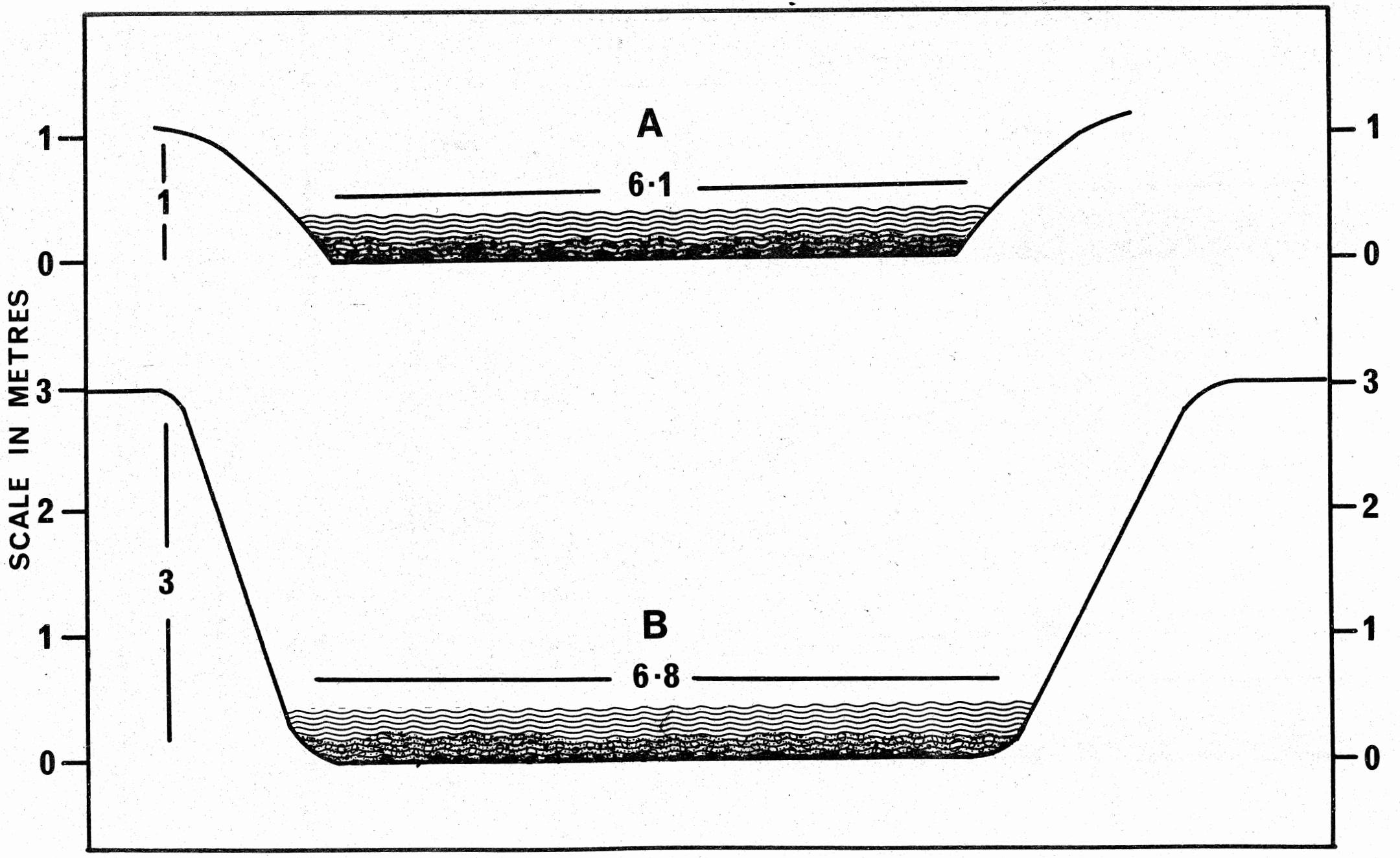

Fig. 2 Cross section of the study area. A - pre-drainage, B - post drainage

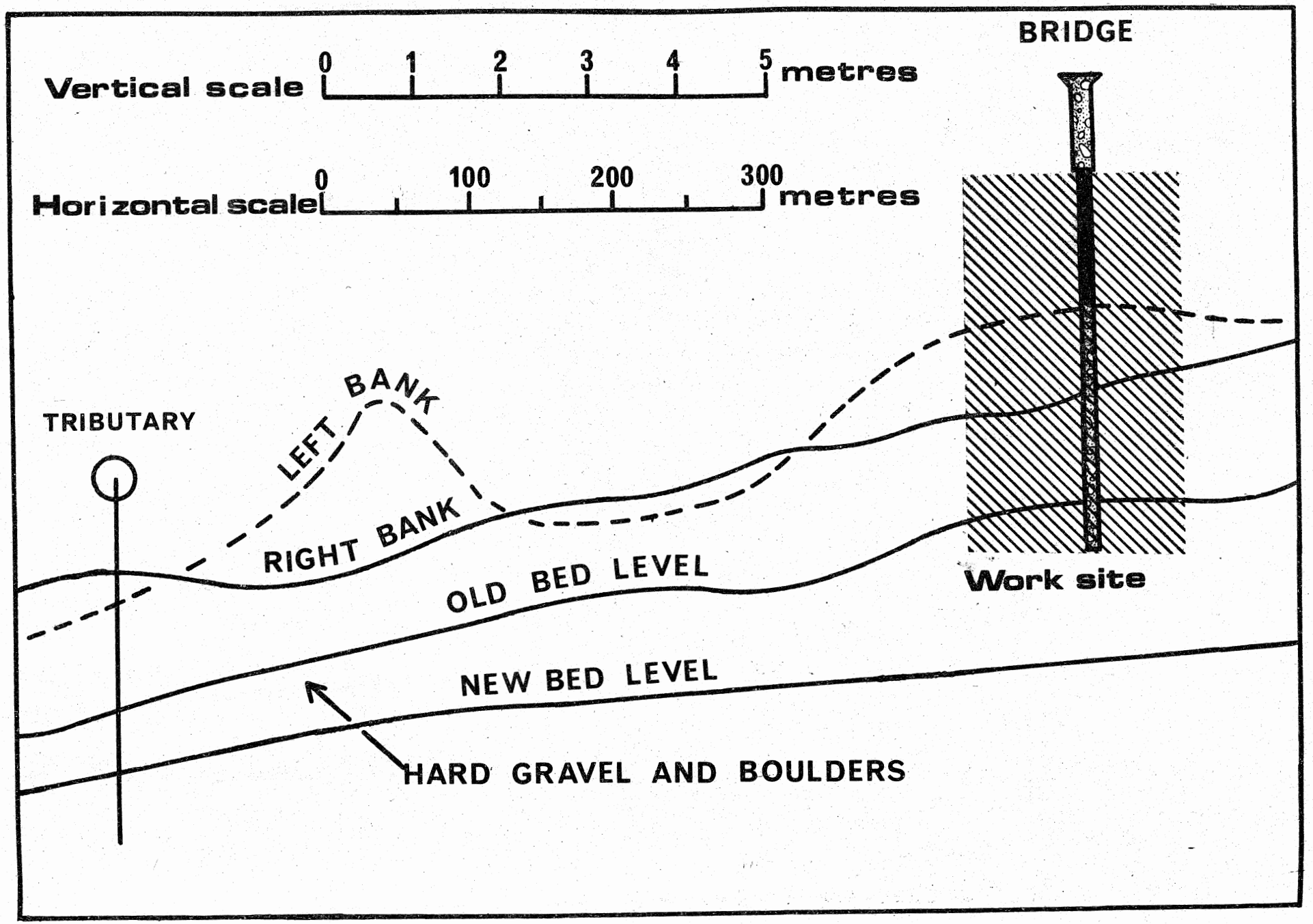

Fig. 3 Longitudinal section of the Trimblestown River, showing old and new bed levels.
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